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## Applying Agile to Mitigate the Risk of Transitioning Defense Embedded Software Technologies

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# Applying Agile to Mitigate the Risk of Transitioning Defense Embedded Software Technologies

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## Abstract

The Department of Defense utilizes emerging embedded software technologies to enhance its warfighting capabilities; however, the transition process is often inefficient and ineffective, and carries certain risks. Weapon system development typically occurs within a traditional bureaucratic framework characterized by heavy regulatory restrictions, a culture laden with security constraints, hierarchical decision-making, funding limitations, safety concerns, lack of adherence to processes, communication/coordination failures, and risk averse mindsets. Promising technologies often face significant obstacles, which can hinder or prevent their progression from development to operational use. Applying modern software acquisition and development principles to the embedded software technology transition processes can boost efficiency and effectiveness, and mitigate risk. As a result, the technology that our warfighters need could be delivered “at the speed of relevance” (Defense Innovation Board, 2019, p. 2).

This paper will identify which of the 12 Agile Manifesto principles are effective in reducing inefficiencies when applied to defense programs, and will outline the benefits that can be realized. Additionally, it will provide examples of successful implementation demonstrated by current and past defense programs. In conclusion, while it is an investment that will take resources and time before realizing results, we assert that it will be well worth it to improve the likelihood of success to transfer technology for use on modern defense systems.

**Keywords:** Embedded Software, Transition, Risk, Agile, Valley of Death

## Introduction

The world has witnessed a rapid increase in new technologies. Technologies such as generative AI, quantum and edge computing, autonomous vehicles and drones, cybersecurity, augmented reality, and robotics have enabled unprecedented capabilities and new opportunities. The United States Department of Defense (DoD) has advanced new technologies to defensive and offensive systems making military operations more efficient, effective, and safer for personnel. DoD however is encountering many challenges with incorporating new technologies. Integration, to ensure compatibility and interoperability between old and new systems, is one of these challenges facing the DoD. Others include cybersecurity risks, training and skills gaps, cost and budget constraints, and regulatory and ethical concerns.

This paper investigates the benefits and opportunities of using modern agile principles to significantly aid in transitioning new technologies. The premise is that the transition of technology within an agile environment provides the relevant backdrop to mitigate or

significantly reduce the obstacles facing current DoD technology transfers. Other benefits of establishing an agile setting include an increase in flexibility and responsiveness, reduced program risks, enhanced collaboration, and continuous improvement, all of which facilitate DoD technology transfer.

We researched a variety of DoD programs intended to integrate new technologies to meet growing performance requirements or fill a capability gap. We found that these programs were influenced by typical forces, which could have restrained their success. Our investigation revealed that successful programs implemented the agile principles with a growth mindset.

Our first task was to identify those forces which increased the likelihood of failure (restraining forces) and those which propelled the program to success (driving forces). By reviewing program historical files, we discovered that most acquisition programs experience a similar and recurring set of restraining forces due to the traditional culture and the environment of DoD program offices. Without intervention, and if left unchecked, these acquisition programs would likely have been unsuccessful. Consequently, the list of restraining forces, as shown in the Force Field Analysis (Figure 1), frequently impact DoD systems. On the other hand, the driving forces are characteristic of highly successful programs which implement the 12 principles identified in the Agile Manifesto.

## Agile Methodology and Principles

Agile methodologies emphasize iterative development, which allows for continuous feedback and improvements. This is particularly useful when transitioning technology, as it enables teams to adapt to changes and address issues promptly. Agile and DevOps methodologies contribute to customer-centric approaches and service optimization. By integrating these methodologies, organizations can foster a culture of innovation and continuous improvement. Agile is quickly overtaking waterfall as the methodology for developing products.

Making the switch from “traditional” project management to agile is not always straightforward, and it can be particularly challenging for organizations that are accustomed to a predictive environment. However, with the right guidance and support, the transition doesn't have to be overwhelming.

Agile technology supports innovation by fostering a flexible and adaptive environment that encourages continuous improvement and rapid iteration. Here are some key points on how agile methodologies contribute to innovation.

1. **Customer Satisfaction**: Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. **Welcome Change**: Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. **Frequent Delivery**: Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. **Collaboration**: Business people and developers must collaborate daily throughout the project.
5. **Motivated Individuals**: Build projects around motivated individuals. Give them the environment and support they need and trust them to get the job done.
6. **Face-to-Face Conversation**: The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. **Working Software**: Working software is the primary measure of progress.

8. **Sustainable Development**: Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. **Technical Excellence**: Continuous attention to technical excellence and good design enhances agility.
10. **Simplicity**: Simplicity—the art of maximizing the amount of work not done—is essential.
11. **Self-Organizing Teams**: The best architectures, requirements, and designs emerge from self-organizing teams.
12. **Retrospection**: At regular intervals, the team reflects on how to become more efficient, then tunes and adjusts its behavior accordingly.

## Using Force Field Analysis to Drive Change

In this paper we apply the Force Field Analysis management tool to diagnosis the internal and external forces that form the DoD, program office, acquisition environment and culture. With the forces in balance and at equilibrium, the environment and culture remain stable. To change the environment, forces, whether driving (positive) or restraining (negative), need to be either strengthened or weakened. The driving (positive) forces are defined as those which will produce a change in the organization toward the desired direction. For example, an organization may want to establish a culture that fosters open communications. Any force which will move the organization in that direction is considered a driving or positive force. Restraining (negative) forces, on the other hand, are those forces that will result in producing an environment opposite to what is desired. The intent is to weaken the restraining forces so that the driving forces overcome those restraining forces and generate the desired outcome, namely, an acquisition environment and culture that support the application of agile principles.

In this paper, the authors selected restraining or negative forces based on the information from program historical files. For example, if a program were plagued by a backlog of volatile requirements and unstable priorities reducing progress or causing the program to stagnate, volatile requirements and unstable priorities was selected as a restraining force.

The purpose of using the Force Field Analysis is to change the program office culture so that as resources (financial, manpower, schedule, material, etc.) are applied, the acquisition program avoids stagnation and quickly progresses through the required acquisition phases. Stagnation becomes a roadblock and prevents a program from advancing to successful completion. This stagnation is often termed the “Valley of Death.” Applying resources with no effect eventually causes a program to languish and likely “die” or be canceled.

We discovered that this acquisition gap or period of stagnation typically lasts for 1–2 years, during which program resources of adequate finances, available time and manpower, and acceptable materials, fail to move the program forward, resulting in the program dying in the proverbial “Valley of Death.”

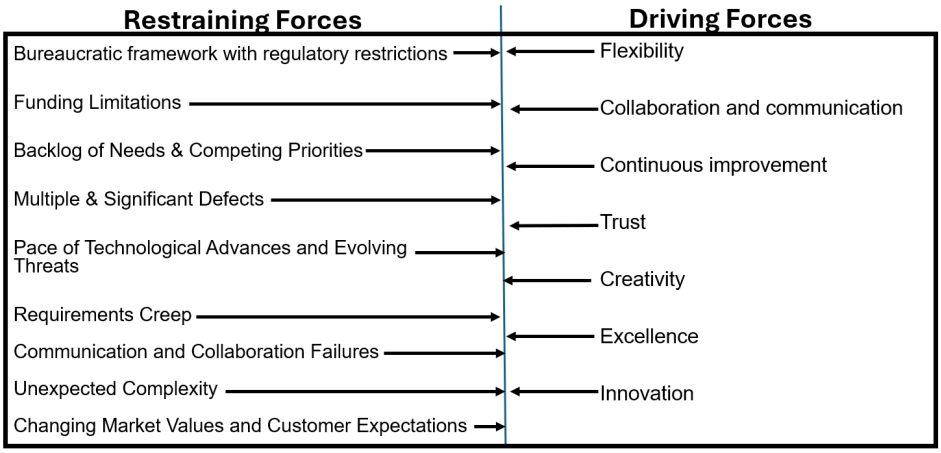


**Figure 1. Force Field Analysis for Implementing an Agile Environment**

## Sample Programs Implementation

Each of the following defense programs demonstrated an improved acquisition outcome by mitigating one or more of their identified challenges, some of which were restraining forces considered for this paper.

## Restraining Force – Bureaucratic Framework & Restrictions

### Program – Army Robotic Combat Vehicle

#### *Proposed Application of Related Agile Principles*

Highlighted principles indicate author's interpretation of which were applied on the Army Robotic Combat Vehicle program.

| Agile Principles | 1 - Customer Satisfaction | 2 – Welcome Change | 3 – Frequent Delivery | 4 –Collaboration | 5 – Motivated Individuals | 6 – Face to face Conversation | 7 – Working Software | 8 – Sustainable Development | 9 – Technical Excellence | 10 - Simplicity | 11 – Self Organizing Teams | 12 - Retrospection |
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### Program Analysis

The program office for the Robotic Combat Vehicle (RCV) Program began during DoD's full endorsement and implementation of its traditional, heavily burdened, acquisition framework. This framework is overwhelmed with regulatory restrictions and scrupulous compliance. The entire acquisition process was laden with required documented processes and overbearing oversight. The objectives of the RCV program were to achieve advanced system performance and to integrate innovative technologies such as artificial intelligence for autonomy and self-decision-making. Consequently, technical requirements were highly volatile and often delayed progress on the program even though substantial resources were allocated and consumed. Frequently, the decision-makers in the program office met with significant bureaucratic resistance to implement a change in the traditional process.

When a change in the acquisition process was accepted and the agile principles were incorporated, the program experienced several characteristics commonly found in a program conducted within an agile environment. When the program office implemented the Middle-Tier of Acquisition (MTA) pathway concurrently with the Software Acquisition (SWA) pathway as

described in the Adaptive Acquisition Framework (AAF), delivery time for the individual embedded software increments significantly decreased, while capability releases provided an increase in performance from the technologies that were promptly integrated into the release. The new embedded technologies enabled the integration of artificial intelligence in the RCV, which permits the processing of vast amounts of data and informed decision-making in real time situations. The operational units receiving the rapid deployment of upgraded robotic systems also noted an increase in operational efficiency and effectiveness.

These technologies which prototyped autonomous software and processes for the RCV program received increased prioritization in the development effort due to rapid prototyping and the flexibility to "fail fast, fail often, and learn." As learning took place, the program remained adaptable to accommodating the constant adjustments and evolving technical requirements necessary to meet the changing needs of the program and to leverage industry experience and expertise.

Not only did the agile environment produce significant benefits for the RCV system, but it also supported an improvement in the acquisition culture and in the way the program office was managed. The program office received more frequent and consistent input from department leadership with reduced bureaucratic hurdles and barriers. With the reduced administrative framework and regulatory restrictions, monthly governance meetings were conducted along with Component Acquisition Executive (CAE) quarterly meetings to discuss the MTA portfolio. These meetings helped to streamline decision-making and further reduce managerial delays.

## Restraining Force – Funding Limitations

### Program - VH-92A Presidential Helicopter

#### *Proposed Application of Related Agile Principles*

Highlighted principles indicate author's interpretation of which were applied on the VH-92A Presidential Helicopter program.

| **Agile Principles** | 1 - Customer Satisfaction | 2 – Welcome Change | 3 – Frequent Delivery | 4 –Collaboration | 5 – Motivated Individuals | 6 – Face to face Conversation | 7 – Working Software | 8 – Sustainable Development | 9 – Technical Excellence | 10 - Simplicity | 11 – Self Organizing Teams | 12 - Retrospection |
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### Program Analysis

By implementing agile principles, the VH-92A Presidential Helicopter program office overcame significant funding constraints and ultimately reduced the cost of the program by about 10% of its original 2014 estimate, while still achieving program objectives and meeting system requirements.

The defense contractor, Sikorsky, a Lockheed Martin Company, worked together with the program office to achieve substantial cost savings. The program office developed an adaptable acquisition strategy, which Sikorsky executed. Through collaboration between the contractor and the government technical workforce, Sikorsky was able to deliver technically excellent products. The Navy program office worked effectively with its contractors to address any technical and management issues and to implement coordinated solutions. The acquisition strategy identified the Navy program office as the Lead System Integrator (LSI). In the LSI model, the Navy takes a more active role in managing the integration of developed systems into the aircraft.

The decision to begin with and modify the FAA-certified Sikorsky, S-92 aircraft, known for its safety and reliability, produced perhaps the most substantial reduction in development costs. As a baseline prototype system, the program office integrated government-defined mission systems and high-tech capabilities into the commercial helicopter. As a result, the contractor was able to tailor and streamline its processes for increased efficiency. As a priority, Sikorsky developed working-software, which provided extensive secure and non-secure communication systems. The Navy worked closely with Sikorsky and other contractors to include electromagnetic pulse hardening and a crash-survivable, flight-information recorder sensor. In addition, the government-contractor team resolved issues related to electromagnetic event survivability and landing zone suitability. Technical features such as day/night and all-weather operations, a self-contained navigation system, and a global positioning system were included to deliver a fully high-tech, capable system.

The program office took advantage of additional cost saving initiatives. For example, instead of contracting for maintenance, the Navy leveraged its existing resources of personnel and facilities, as well as its established infrastructure. The effective use of available resources and infrastructure avoided the need to send the aircraft back to the developer for maintenance. Another example of implementing a substantial, cost-saving, initiative relates to part shortages. The lack or delay of aircraft maintenance parts increases costs and results in significant flight downtime. To resolve this cost-related issue, the program office initiated a tracking system to identify and resolve the delay of parts.

## Restraining Force – Backlog of Needs & Competing Priorities

### Program - Joint Program Executive Office - Chemical, Biological, Radiological, and Nuclear Defense

#### *Proposed Application of Related Agile Principles*

Highlighted principles indicate author's interpretation of which were applied on the Chemical, Biological, Radiological, and Nuclear Defense (CBRND) program.

| **Agile Principles** | 1 - Customer Satisfaction | 2 – Welcome Change | 3 – Frequent Delivery | 4 –Collaboration | 5 – Motivated Individuals | 6 – Face to face Conversation | 7 – Working Software | 8 – Sustainable Development | 9 – Technical Excellence | 10 - Simplicity | 11 – Self Organizing Teams | 12 - Retrospection |
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### Program Analysis

Perhaps one of the most challenging tasks in weapon system development is to establish operational requirements for a robust and effective warfighting capability. As challenging as this is, the effort becomes even more overwhelming when considering multiple factors such as the operational environment, the cultural background of stakeholders, organizational responsibilities, tight schedules, etc. Each of these interests often have a set of volatile and unstable requirements which are unaligned and compete with others for consideration. This is the situation in the CBRND program office, which is charged with informed decision-making in support of competing and often conflicting joint force requirements. The goal of the CBRND program is to integrate advanced sensors and data analytic technologies for medical countermeasures, protective equipment, and detection systems into existing systems and platforms to enhance threat detection and response.

The design and improvement of chemical and biological detection technologies are frequently occurring and provide advanced capabilities. However, the selection of which

capabilities to acquire or integrate depends on competing priorities, stakeholders' operational needs, and mission objectives. The amount of cutting-edge technology insertion directly impacts the deployment schedule. While both the need for technology and field-deployment is driven by operational and possibly combat conditions, the joint program office needs to provide a balanced resolution.

Developing new technologies comes at a cost, and decisions need to be made between maintaining current capabilities and acquiring innovative, chemical and biological detection systems. Funding for research programs is often limited due to the accelerated pace of technology development and the scarcity of designated funds for research. Likewise funding for maintenance of fielded systems is competitive. Therefore, the program office needs to prioritize funding priorities not only among promising technologies, but also between maintaining the capability of current and legacy systems and acquiring novel and advanced technologies.

The program office applied several agile principles leading to successfully achieving program objectives. For example, when capability demonstrations and engagements were conducted or when decisions on platforms were considered, all branches of service and stakeholders were invited to observe so that quick pivots and reprioritization of user needs were made from the feedback of all interested participants.

## Restraining Force – Multiple & Significant Software Defects

### Program – ARMY PEO Enterprise Information Systems

#### *Proposed Application of Related Agile Principles*

Highlighted principles indicate author's interpretation of which were applied on the Army Program Executive Office (PEO) Enterprise Information Systems program.

| **Agile Principles** | 1 - Customer Satisfaction | 2 – Welcome Change | 3 – Frequent Delivery | 4 –Collaboration | 5 – Motivated Individuals | 6 – Face to face Conversation | 7 – Working Software | 8 – Sustainable Development | 9 – Technical Excellence | 10 - Simplicity | 11 – Self Organizing Teams | 12 - Retrospection |
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### Program Analysis

The vision of the Army's PEO Enterprise effort is to transform the Army's current business acquisition organization into an agile environment taking advantage of speed, simplicity, and excellence in delivering capabilities. To fulfill this vision, PEO Enterprise supports every domain, branch, and unit worldwide with the expectation of modernizing, enhancing, and managing the Army's enterprise business systems that keep the Army operating efficiently.

Enterprise business systems rely on high-quality software and software products. Producing and delivering working software, that is, software free from defects, is essential to successful mission performance. Therefore, an important goal of PEO Enterprise is to reduce or eliminate significant software errors and defects. PEO Enterprise attempts to eliminate multiple and significant software defects by implementing key test strategies through a comprehensive agile transformation process. Test strategies are frequently incorporated into the software development process enabling developers and testers to quickly find and resolve software defects. Through early and continuous testing, defects are identified and resolved before becoming deeply embedded in the software design at a higher architectural level. Regular and incremental testing of software encourages frequent and continuous user feedback and assists in identifying software design criteria. The U.S. Army Test and Evaluation Command (ATEC)

can significantly contribute to the process of producing error-free software by observing how software tests are designed and conducted. ATEC's review of test data during the development process adds credibility to the test evaluation and results and provides feedback to developers and other stakeholders. In addition to developmental test results, demonstrations of operational capabilities, while conducting realistic scenarios, provide necessary feedback to stakeholders, encourage collaboration, and welcome any changes required to completely satisfy the customer.

The agile practice of retrospection provides time for reflection on how well the organization is working to reduce or eliminate software defects and what changes need to be made. The retrospective considers any functional area or domain, which can help achieve its goal. For example, it may consider what further amount and type of manpower are required to effectively and efficiently test software during development, deployment, and delivery.

A retrospective considers organizational change in other functional domains which support an agile environment. These changes can also help to reduce software defects, increase delivery speed, and incorporate technical excellence. Software data, which is visible, accessible, understandable, linked, trusted, interoperable, and secure confirms the validity of accurate test results. Highly trained personnel and those skilled in developing and understanding software applications and information technology services determine the approach to developing appropriate tests and evaluate collected data. Appropriate funding and type of contract ensure adequate financial support and agreements necessary to fully implement the required software testing and review of the results. And finally, the appropriate acquisition professionals, domain specialists, needed facilities and supplies, and force structure secure the environment to produce working software free from defects and error.

## Restraining Force – Slow Pace of Technological Advances & the Evolving Threat

### Program - ARMY Joint Common Access Platform (JCAP)

#### *Proposed Application of Related Agile Principles*

Highlighted principles indicate author's interpretation of which were applied on the Army Joint Common Access Platform (JCAP) program.

| **Agile Principles** | 1 - Customer Satisfaction | 2 – Welcome Change | 3 – Frequent Delivery | 4 –Collaboration | 5 – Motivated Individuals | 6 – Face to face Conversation | 7 – Working Software | 8 – Sustainable Development | 9 – Technical Excellence | 10 - Simplicity | 11 – Self Organizing Teams | 12 - Retrospection |
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### Program Analysis

One of the restraining forces directly associated with transitioning embedded defense technologies is related to the pace at which the technology software is developed and deployed. These defense technologies are effective in countering the evolving threat. According to the 2025 Annual Threat Assessment, both the number of threats and their source are growing at an escalating rate. New advanced threat technologies, digital warfare, and system vulnerabilities are the main causes of the increase in attacks.

The Army's JCAP supports U.S. Cyber Command (USCYBERCOM) by providing a protected environment from which to execute coordinated cyber-attacks against approved targets. JCAP enables DoD cyber operators to connect to their targets and neutralize the rapidly evolving foreign threats from nations such as China, Russia, Iran, and North Korea.

To keep pace with the evolving multi-national threat, the JCAP program office must implement an agile environment for software development. Program success is measured by the effectiveness of U.S. offensive attacks against threats and the U.S. ability to defend its national infrastructure and defense systems. Success will require a software development environment which welcomes changing requirements, frequently delivers offensive and defensive cyber software, and incorporates excellence in developing cutting edge technologies. This type of environment is characteristic of an agile organization which routinely generates working software with minimal or no significant defects.

Even though the JCAP program has shown continuing success, it faces significant and ongoing challenges. JCAP integrates cyber capabilities from among several stakeholders and across defense components. Each of these capabilities are often unique in their architecture and design. JCAP is responsible for integrating these capabilities into a single platform and providing seamless operations. While maintaining operational effectiveness, JCAP is charged with incorporating advanced and emerging technologies. Even though JCAP is an offensive system, it must also provide defensive security against cyber-attacks against itself. Balancing the need for rapidly incorporating offensive and defensive capabilities and the need for thorough and rigorous testing is another challenge that requires continuous and regular assessments of the gaps that exist among threats, system requirements, available, and advance technologies.

## Restraining Force – Requirements Creep

### Program - Special Operations Command (SOCOM) MQ-9 Reaper Unmanned Air Vehicle (UAV)

#### *Proposed Application of Related Agile Principles*

Highlighted principles indicate author's interpretation of which were applied on the MQ-9 Reaper Unmanned Air Vehicle (UAV) program.

| **Agile Principles** | 1 - Customer Satisfaction | 2 – Welcome Change | 3 – Frequent Delivery | 4 –Collaboration | 5 – Motivated Individuals | 6 – Face to face Conversation | 7 – Working Software | 8 – Sustainable Development | 9 – Technical Excellence | 10 - Simplicity | 11 – Self Organizing Teams | 12 - Retrospection |
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### Program Analysis

Today's agile software development environment consists of a mix of several methods that were invented in the early 2000s. Popularity advanced quickly in private industry, but not as quickly on government software development projects. DoD issued policy and guidance in 2020; however, the new policy and guidance had not been fully adopted by most DoD programs. Since there is no one right way for every program implementation, a wide range of lessons learned are driving best practices.

Software development on the SOCOM MQ-1 and MQ-9 Combat Air Patrol programs has provided direct support to the weapon systems operational flight program for many years. When urgent requirements are received from SOCOM, the standard procedure has been to simply add capability to an existing legacy system without regard for efficiency. Because the program office relied on a software "waterfall" development, the software took time to produce. Quick and frequent releases were unheard of. Instead, a validated set of requirements and a designated verification test plan were generated in the early planning stages. If requirements changed, the contract and all documentation had to be modified. Cost was incurred and schedules suffered, since neither cost nor schedule was planned for.

So that the program office would be able to adequately respond to SOCOM's need for capability additions, the program manager, responsible for the MQ-1 and MQ-9 software development, implemented a service type contract. The contract required delivery of a repeatable process, which included 6 months of development followed by 6 months of test. It was their way to implement schedule-driven capability development. Unfortunately, they did not account for the time that would be needed to integrate and perform lab testing.

Since multiple end-user demonstrations were conducted to curb requirements creep, the program office was forced to reduce time for coding and testing. As a result, numerous critical defects were discovered, which required further rework and additional deliveries to correct the software errors and deficiencies. Consequently, previously scheduled, major software deliveries releases were delayed. Therefore, the program experienced overall significant schedule delays when software tests were not adequately conducted.

With each new scope change release, the development contractor was given a choice to either create a new Minimum Viable Capability Release (MVCR), include the new scope in the next planned Minimum Viable Product (MVP), or add the change to a later release. The software development team delivered 50+ new end-user requirements, 500+ software changes initiated by the contractor, and 100+ development and operational test defects, yet still fielded six operational flight programs. Progress was considered successful even though releases were not delivered as planned. Improvement was evident when schedule slips were reported in days and weeks instead of historically in months and years. Because end-users trusted the team to incorporate operational feedback in the next release, they were satisfied, more so than before. End-users could expect and depend on a 6-to-12-month product delivery schedule. Despite the recognized improvements in schedule, performance goals were not being met.

The development team, PMO, and end users met weekly to resolve process issues. While trusting in the current cadence, SOCOM required more performance capability, faster deliveries, and more reliable software. Consequently, the program office implemented Agile principles, for example, responding to change with more frequent deliveries of working (demonstratable) software. They increased their collaboration with end-users and emphasized the necessity for motivated individuals and frequent communications. As the software development team embraced the agile principles, they were able to increase delivery frequency, which improved customer satisfaction.

The program manager switched to using a level-of-effort type contract to avoid the complexity and time it took to make requirement changes through contract modifications. A dedicated contract team with a repeatable process was put in place to help stabilize funding. When faced with new organizational, cultural, and legal challenges, the program office developed engagement rules to control requirements volatility. They learned that an increase in the frequency and number of deliveries translated into a heavier workload for the program office in the form of oversight.

In their attempt to mimic private industry's speed to market, it became clear that military systems are more complicated and unique than commercial systems. Independent military test organizations needed for achieving system certifications were continually challenged by the uptick in delivery cadence.

Program offices must find ways to implement agile principles that may be different than how other organizations implement them. The MQ-9 Reaper program office embraced the challenge and created success. The most important lesson learned was that all team members and stakeholders had to equally commit and participate in making the changes happen.

## Restraining Force – Communication & Collaboration Failures

### Program - Air Force F-22 Raptor and F-35 Lightning II

***Proposed Application of Related Agile Principles***

Highlighted principles indicate author's interpretation of which were applied on the Air Force F-22 Raptor and F-35 Lightning II programs.

| **Agile Principles** | 1 - Customer Satisfaction | 2 – Welcome Change | 3 – Frequent Delivery | 4 –Collaboration | 5 – Motivated Individuals | 6 – Face to fac e Conversation | 7 – Working Software | 8 – Sustainable Development | 9 – Technical Excellence | 10 - Simplicity | 11 – Self Organizing Teams | 12 - Retrospection |
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**Program Analysis**

Despite endorsement by President Trump's Executive Orders, the FY24 NDAA, the Department of Government Efficiency (DOGE) initiatives to improve efficiency and effectiveness of software modernization methods and DoD acquisition outcomes, significant challenges still exist. Long development cycles are supported by deeply entrenched habits using the Waterfall development method, while culture typically does not support modern practices. Program offices are still highly resistant to change. Implementing change requires more attention to communication and collaboration, as well as gaining the knowledge and implementation skillsets needed.

The F-22 program faced several challenges prior to modernizing efforts. Not adapting an agile mindset, vendors using traditional methods yet failing to meet schedule or performance goals, and proliferation of single, large software deliveries plagued by an overburden amount of documentation resulted in duplication of effort and test challenges, which failed business plans. Change would decrease software deliveries but was needed to move forward.

The F-35 program was also behind in capability upgrades and, like the F-22 contract, development teams did not meet performance goals. The program office faced emerging requirements, which it was not able to manage, causing schedules to slip and threatening overall cost, schedule, and performance goals. Software vendors were unable to deliver timely software updates, especially when faced with unexpected complexity. The F-35 program office began to recognize the need for standardization in the battlefield. Unfortunately, existing software development processes prevented them from achieving planned improvements.

Even with benefits from software acquisition and development policy, guidance, and best practices challenges continue to surface. Even though end-users received working software faster and more frequently, they adjusted to receiving software that did not contain the full set of requirements. There is still major resistance to change, which may be rooted in the lack of knowledge and/or understanding of modern concepts, terminology, and basic implementation methods. Consideration needs to be given when it does not make sense to apply modernization to legacy programs and when modernization would misalign program goals with leadership objectives. The tendency to continue large programs even after significant performance and cost overruns occur should not prevent more aggressive change management.

To eliminate costly changes, the DoD should determine whether software modernization decreases cost, satisfies customers, and improves product quality; but at the same time fund software modernization practices expecting a return on the investment.

## Restraining Force – Unexpected Complexity

### Program - Joint Tactical Radio System (JTRS)

***Proposed Application of Related Agile Principles***

Highlighted principles indicate author's interpretation of which were applied on the Joint Tactical Radio System (JTRS) program.

| Agile Principles | 1 - Customer Satisfaction | 2 – Welcome Change | 3 – Frequent Delivery | 4 –Collaboration | 5 – Motivated Individuals | 6 – Face to fac e Conversation | 7 – Working Software | 8 – Sustainable Development | 9 – Technical Excellence | 10 - Simplicity | 11 – Self Organizing Teams | 12 - Retrospection |
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### Program Analysis

In 1997, DoD initiated the Joint Tactical Radio System (JTRS) communication network program to significantly expand capability. Unfortunately, the program experienced constant delays due to unexpected technical complexity resulting in major cost overruns. The original plan was to implement an open architecture promising to reduce the need for future development, integration, and testing; however, it did not turn out as promised. The program office realized that the additional technology was available and ready to be added to the system; however, the program experienced inadequate integration planning.

Under joint management the program office experienced a significant lack of communication and collaboration. Program costs became uncontrollable from the many technical problems; and after system development struggled, the value of applying basic systems engineering principles became clear.

The program office was able to leverage valuable technology from the competitive environment; however, there was no way to prioritize the large number of initial requirements and interface standards. Consequently, the program struggled with managing concurrent hardware and software development.

Although there were a few early signs of adopting basic agile principles, the JTRS program remains an example of reducing unfavorable effects through an aggressive implementation of agile best practices. Unfortunately, modern software development policy was not codified and released until 2020, even though many of the agile principles were practiced in the early 2000s.

## Restraining Force – Changing Market Demands

### Program - John Deere

***Proposed Application of Related Agile Principles***

Highlighted principles indicate author's interpretation of which were applied on John Deere programs.

| Agile Principles | 1 - Customer Satisfaction | 2 – Welcome Change | 3 – Frequent Delivery | 4 –Collaboration | 5 – Motivated Individuals | 6 – Face to face Conversation | 7 – Working Software | 8 – Sustainable Development | 9 – Technical Excellence | 10 - Simplicity | 11 – Self Organizing Teams | 12 - Retrospection |
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### Program Analysis

John Deere programs demonstrate how they embraced change to the modern software development environment in keeping up with evolving technology complexities, emerging markets, customer needs, and a desire to improve the quality of software products. Use of the Waterfall software development method continued to impose longer than planned development cycles, delayed response, and/or inability to meet emerging customer demands. Company culture was tuned to long term habits that did not serve modern needs.

The company began to learn and implement SCRUM development methods, with a lean twist to facilitate short continuous development, integration, and delivery cycles. They learned and lived migration to an agile mindset while at the same time receiving training and coaching to stay on track.

John Deere management demonstrated their commitment to leading change by showing examples. They were successful at shortening their software development cycles, which enabled them to welcome change to meet emerging customer needs. Their customers became more satisfied with more and faster software deliveries, not to mention the improved product quality. They attribute their accomplishments to all the work they did to make their process more efficient and effective. Multi-discipline communication and collaboration across the company grew naturally as team members became more independent and enthusiastic.

The company learned along the way that management commitment and participation are essential, along with the willingness by everyone in the company to persist until they achieve positive results. They now understand that product and process improvement requires the continuous attention of everyone in the company and to all types of effort presented (i.e., training, communication, collaboration, etc.). They should be proud of their success!

## Conclusions

Each of the examples presented in this paper applied agile principles and demonstrated an increased likelihood of successfully transitioning state-of-the-art technologies. Historical demonstration of success along with stronger directives, policy, and guidance will enable the momentum needed to accelerate changes to get capability to warfighters faster.

President Trump's executive orders related to software acquisition focus on enhancing the efficiency and effectiveness of the acquisition workforce, particularly within the Department of Defense (DoD). These orders emphasize the importance of delivering high-quality, secure software quickly through reuse, acquisition, or custom development. The key focus is on enabling the delivery of resilient software capabilities at the speed of relevance, which is crucial for maintaining a competitive advantage in modern military operations.

Another notable effort is the Software Modernization Initiative, launched under the Department of Government Efficiency (DOGE), aimed at improving the quality and efficiency of government-wide software, network infrastructure, and IT systems.

These efforts align with broader initiatives to streamline operations, reduce inefficiencies, and promote multi-discipline, multi-functional, and cross-departmental collaboration. The initiatives also emphasize the importance of modern software acquisition practices, such as the use of the Software Acquisition Pathway, which supports use of agile principles.

Defense Secretary Pete Hegseth's memo, "Directing Modern Software Acquisition to Maximize Lethality," issued March 6, 2025, states that "software is at the core of every weapon and supporting system we field to remain the strongest, most lethal fighting force in the world.”

One official at DoD News, after referencing Pete Hegseth's memo, stated that "as DoD races to implement the secretary's directive, the stakes are high. … Software-defined warfare is not a future construct, but the reality we find ourselves operating in today" (Lopez & Shinego, 2025).

The most recent testimonial was presented by Sean Brady, Director, Software Acquisition & Sustainment (A&S), DoD SW Cadre Deputy Director, Joint Interoperability, March 19, 2025, at DAU's monthly "Let's Talk Agile" webinar. He reported that the newly formed DoD SW Cadre's mission is to accelerate transformation to modern SW acquisition environments. To "move out" smarter/faster, program managers recommend support from the A&S Software Enablement Team. The authors strongly recommend that program offices invest in implementing agile principles to improve technology transfer in current and future defense weapon systems.

## References


Althris Training. (2024). *Agile transformation at John Deere: A case study in lean and agile practices*. https://www.linkedin.com/pulse/agile-transformation-john-deere-case-study-lean-practices-althris-fktve/

Brady, S. (2025). *Let's talk agile: Take 4 with Sean Brady software pathway policy updates*. https://www.dau.edu/events/lets-talk-agile-take-4-sean-brady-software-pathway-policy-updates

Carpenter, D. (2025, March 7). *Bolstering defense tech cybersecurity from the start*. https://www.nationaldefensemagazine.org/articles/2025/3/7/bolstering-defense-tech-cybersecurity-from-the-start

Center for Public Policy and Private Enterprise. (2012). *The Joint Tactical Radio System: Lessons learned and the way forward*. University of Maryland, School of Public Policy. https://apps.dtic.mil/sti/pdfs/ADA623331.pdf

Christ, E. (2023, October 27). Army strategizes shift to agile test and evaluation of software. https://www.eis.army.mil/newsroom/news/peo-eis-wide/army-strategizes-shift-agile-test-and-evaluation-software

Cornwell, M. (n.d.). *Defense acquisition overview: DoD defense acquisition framework (Acquisition pathways)*. https://dau365.sharepoint.com/:p:/r/sites/Class-Template-EXE4000/_layouts/15/Doc.aspx?sourcedoc=%7B538C1914-7956-42E6-BC15-2F7DF75060E8%7D&file=20241209%20CORNWELL%20AAF%20EXE4000.pptx&action=edit&mobileredirect=true

DAU. (n.d.). *FY 25 NDAA Section 832 field training teams: CONOPS review with deans and directors*. https://dau365.sharepoint.com/:p:/r/sites/ADOMA/_layouts/15/Doc.aspx?sourcedoc=%7BD8CD6C88-4E2E-43C3-8762-05AFDAFF2953%7D&file=Sec.%20832%20FTT%20CONOPS%20Overview%20for%20Deans%20&%20Directors%20(27%20Mar%202025).pptx=&action=edit&mobileredirect=true arch 27, 2025)

Defense Innovation Board. (2019). *Software is never done: Refactoring the acquisition code for competitive advantage*. https://media.defense.gov/2019/May/01/2002126690/-1/-1/0/SWAP%20EXECUTIVE%20SUMMARY.PDF

Defense Scoop. (2025, June 9–13). *Defense Tech Week website*. https://defensescoop.com/2023/04/12/us-cyber-command-requests-nearly-90m-for-offensive-platform/

Department of Defense. (2025, March 6). *Directing modern software acquisition to maximize lethality* [Memorandum]. https://media.defense.gov/2025/Mar/07/2003662943/-1/-1/1/DIRECTING-MODERN-SOFTWARE-ACQUISITION-TO-MAXIMIZE-LETHALITY.PDF

GAO. (2018). *VH-92A Program is stable and making progress while facing challenges* (GAO-18-359). https://www.gao.gov/products/gao-18-359

GAO. (2024). *DoD acquisition reform* (GAO-25-107003). https://www.gao.gov/assets/gao-25-107003.pdf

Green, C., & Hammer, C. (n.d.). *U.S. Army, Program Executive Office, Intelligence, Electronic Warfare, and Sensors website*. https://peoiews.army.mil/pm-cs/

Hillman, A. (2024, February 6). *CSC2 moves full speed ahead on the software acquisition pathway*. https://www.jpeocbrnd.osd.mil/Media/News/Article/3666146/csc2-moves-full-speed-ahead-on-the-software-acquisition-pathway/

Kowal-Swartout, P. A. (2023). *Software integration options for the F-22 and F-35 Major Defense Acquisition Programs* (Master's thesis, Naval Postgraduate School). https://hdl.handle.net/10945/72206

Lawton, D. (2023, May 19). *How agile is changing the way PEO EIS develops software*. https://www.eis.army.mil/newsroom/news/peo-eis-wide-data/how-agile-changing-way-peo-eis-develops-software

Lopez, C. T., & Shinego, W. (2025). *Modern software acquisition to speed delivery, boost warfighter lethality*. Department of Defense News. https://www.defense.gov/News/News-Stories/Article/Article/4114775/modern-software-acquisition-to-speed-delivery-boost-warfighter-lethality/

Office of the Director of National Intelligence. (2025, March). *Annual threat assessment of the U.S. intelligence community (U)*. https://www.dni.gov/files/ODNI/documents/assessments/ATA-2025-Unclassified-Report.pdf

Robinson, J., Upthegrove, M., Wassink, F., Willis, D., & Willis, T. (n.d.). *Presidential Helicopter Replacement Program (VH-92A)*. https://dau365.sharepoint.com/:p:/r/sites/Class-Template-BFM3000/_layouts/15/Doc.aspx?sourcedoc=%7B1B17FB6F-A19D-4503-8E0F-15F0F287BB2C%7D&file=VH%2092A%20Final%20Briefing.pptx&action=edit&mobileredirect=true

Rojoef, M. (April 4, 2024). *US taps consortium for Army's robotic combat vehicle software Prototype*. The Defense Post. https://thedefensepost.com/2024/04/04/us-robotic-combat-vehicle-software/

Smith, A. (2018, September–October). Agile values in the MQ-9 Reaper's software development. *Defense Acquisition Magazine*. https://www.dau.edu/library/damag/september-october2018/agile-values-mq-9-reapers-software-development

U.S. Army, Program Executive Office, Intelligence, Electronic Warfare, and Sensors. (2022, December 28). *Warfighter-centered design through agile software development to pace the threat.* https://peoiews.army.mil/2022/12/28/warfighter-centered-design-through-agile-software-development-to-pace-the-threat/

Utara, C. (2016, June 24). *Organic lead system integrator overview.* https://dau365.sharepoint.com/:p:/r/sites/CURDEV-PCO-ETM/_layouts/15/Doc.aspx?sourcedoc=%7BD39480F6-31AB-462E-A617-56CCB27756D0%7D&file=Organic%20LSI%20V002_00.pptx&action=edit&mobileredirect=true


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